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UTILIZATION OF SURPLUS PRUNES

E. M. MRAK and W. V. CRUESS

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UTILIZATION OF SURPLUS PRUNES

E. M. MRAK[1] AND W. V. CRUESS[2]

In a recent bulletin on the prune situation S. W. Shear[3] states that apparently the bearing acreage of prunes in California will continue to increase for several years, and the average production likewise, if the average yields do not decline greatly. The production of prunes in California by five-year averages, and for 1926, 1927 and 1928 has been:

Years	Tons	Years	Tons
1900–1905	64,120	1920–1925	129,000
1905–1910	67,800	1926	150,000
1910–1915	78,800	1927	225,000
1915–1920	93,000	1928	220,000

Even if production in Europe does not increase, according to Shear we may expect an average annual world production of 270,000 tons of dried prunes for the next few years. Approximately this quantity was produced in 1927 when the world's prune crop was marketed only with great difficulty and at very low prices.

A study of the situation indicates that during the present period of heavy production, prunes of poor quality and very small size should not be permitted to compete directly with those of the better grades and sizes, but should instead be diverted to other and non-competitive uses. There is, moreover, reason to believe that the consumption of the French variety of prunes could be considerably increased if a more satisfactory method of canning prunes "ready-to-serve"[4] could be found and the present technical difficulties of the canning process overcome.

The investigations made to substantiate these ideas and which are reported in this publication were made possible by the cooperation and financial aid of the California Prune and Apricot Growers Asso-

[1] Research Assistant in Fruit Products.

[2] Associate Professor of Fruit Products and Chemist in the Experiment Station.

[3] Shear, S. W. Prune supply and price situation. California Agr. Exp. Sta. Bul. 462:1–70. 1928.

[4] "Ready-to-serve" prunes is the term applied to cooked prunes canned in syrup.

ciation. The investigations were first conducted in the Fruit Products Laboratory, University of California. The most promising new products were then recommended to various manufacturers for trial and several of them have been successfully placed on the market.

Many inquiries are received from prune growers, dried fruit packers, canners and others for information regarding these investigations. This report has been prepared to supply this information.

PRESENT METHODS OF PACKING AND UTILIZING PRUNES

Most of the dried prunes of California are size-graded, processed in hot water and then packed in 1 and 2-pound cartons and in 5, 10 and 25-pound wooden or fiber-board boxes.

Some dried prunes are canned in syrup ("ready-to-serve" prunes), but the output is comparatively small because the fruit reacts with the tin plate to form hydrogen gas which causes swelling of the cans and heavy losses to the canners.

So called "dry-pack" prunes are dried prunes processed until soft and are then packed without syrup. They have not been in very great demand, probably because of inadequate advertising and because they have been packed in large cans to compete with bulk prunes for cooking for table use. If the dry-pack prunes were packed in 4-ounce cans it is believed that they would be purchased to be eaten "out-of-hand" in the same manner as fresh fruit or candy without further cooking, as they are moist, tender and excellent for this purpose. Mothers have stated that they would like to have such a product for their children. The dry-pack prunes are well adapted to distribution in hot climates in which prunes packed by other methods spoil rapidly.

Small quantities of prunes are pitted and packed in boxes, primarily for the European trade. Pitting machines now in use leave small pieces of pits in some of the prunes, a defect that has probably retarded the development of the demand for the product.

Small quantities of prunes have been used experimentally in various factories in the preparation of vanilla bases, of syrup, juice, glacé fruit, tobacco conditioners, etc., but the quantity of prunes so used has not been large.

Fresh prunes are used extensively in Jugoslavia and Roumania for the manufacture of brandy ("Slivovitz") and an unsweetened jam ("Pekmez," "Pflaumenmus," or "Zwetschenmus").[5] About 40 per

[5] U. S. Dept. Agr. The prune industry of Yugoslavia. Bur. Agr. Economics. Mimeo. Circular, Aug. 13, 1925.

cent of their plum crop is made into brandy and 20 per cent into the jam, "Pekmez." The quantity of fresh prunes used for the manufacture of brandy varies with the price of dried prunes and the crop.

Pekmez, according to J. M. Morrone,[6] is a jam-like product obtained by cooking fresh prunes in large "boilers" (probably kettles) without added sugar and then forcing the cooked fruit through a screen in order to remove the skins and pits. The screened pulp is run into barrels and exported, principally to Germany. Probably some fermentation occurs in the barrels before consumption, as samples examined in the Fruit Products Laboratory contained many yeast cells. It is sold at such a low price that California prune jam cannot compete with it in the European markets.

Prune brandy contains alcohol and therefore cannot be sold in the United States.

INVESTIGATIONS BY THE FRUIT PRODUCTS LABORATORY

Methods of preparing, preserving and utilizing a new product—prune pulp or sieved prunes—were studied and its commercial preparation and utilization have been developed in cooperation with various industries. Most attention has been given to its use in ice cream, fountain beverages, breakfast cereals, bakery products, confectionery, jams and butters, and to its use as a table sauce.

Methods of preparing a bottled juice and prune syrup have been studied. Improvements have been made in the canning of ready-to-serve prunes and in preparing dry-packed canned prunes, so called "French process" glass packed prunes, and in the canning and glass packing of fresh prunes. The possibility of utilizing prunes for the manufacture of industrial alcohol and vinegar has been considered. Some attention also has been given to the utilization of the waste pits from the preparation of prune pulp.

PREPARATION AND UTILIZATION OF PRUNE PULP

As a result of a comparison of the various products prepared from prunes in preliminary experiments it was decided that prune pulp offered the greatest possibilities of commercial success, because it is adapted to several important uses, is easily prepared at low cost with existing cannery equipment, and utilizes any size or grade of whole-

[6] Morrone, J. M. U. S. Trade Commissioner, Rome, Italy, personal communication.

some, edible prunes. Other names than prune pulp, such as "prune fruit," "prune meat," "purée of prunes" and "sieved prunes" have been used in commercial practice since it was developed in the Laboratory.

The product consists of the flesh of cooked prunes freed from pits and large pieces of skin by screening. It has the characteristic odor, flavor, and color of dried prunes. The texture is smooth and the consistency and appearance resemble those of a "fruit butter."

The process of manufacture is simple and consists in washing, cooking and screening the prunes. The simplicity of the manufacturing process, and the small amount of necessary equipment makes possible its production on a small scale as well as in the factory.

Raw Material for Prune Pulp.—The common varieties grown in California, namely, French, Robe de Sergeant, Sugar, and Imperial prunes were all found suitable for use in making the pulp. Most of the prunes produced in California are of the French variety and consequently they were used in most of the experiments.

All sizes and grades of clean, and sound prunes were found satisfactory for the purpose.

Preparation of the Pulp.—It was found necessary to wash the prunes thoroughly with a spray of cold water or by vigorously stirring them in water before using them for pulp.

Several methods of softening the prunes for pulping were compared and the following found best. The washed prunes were covered with water and boiled slowly in a steam-jacketed kettle (see fig. 4) until soft enough to be screened. When a thin pulp was desired the prunes were boiled until the skins began to disintegrate, usually about two hours. When thick pulp was desired they were boiled until soft but not disintegrated, and were then drained. In making the thin pulp the cooked prunes and the water used in cooking were passed through the pulper. In making the thick pulp only the drained prunes were passed through the pulper.

There are three general types of pulping machines, the centrifugal brush pulper, the horizontal brush, and the wood or metal paddle ("cyclone") (fig. 1) pulpers. Any one of these can be used for making screened prune pulp although pulpers equipped with brushes were found to be better than those equipped with wooden or metal paddles. The brushes were found to clean the pits more thoroughly without breaking them, they caused less vibration than the wooden paddles and were not so destructive to the screen.

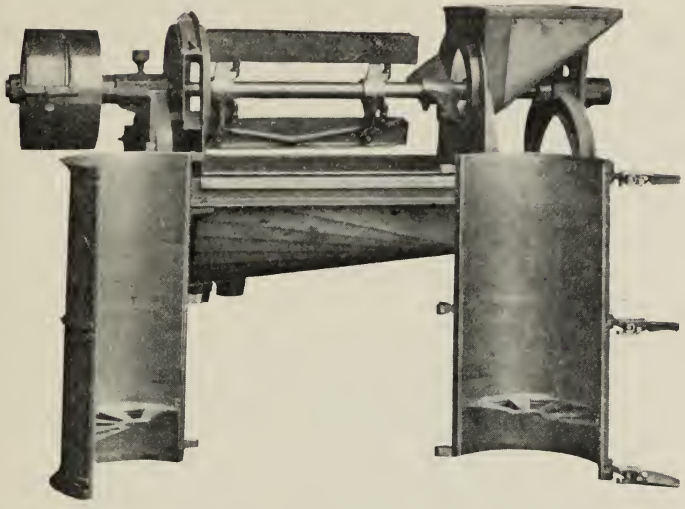

Fig. 1.—Tomato pulper (cyclone) used in preparing prune pulp. (Courtesy Anderson-Barngrover Manufacturing Co.)

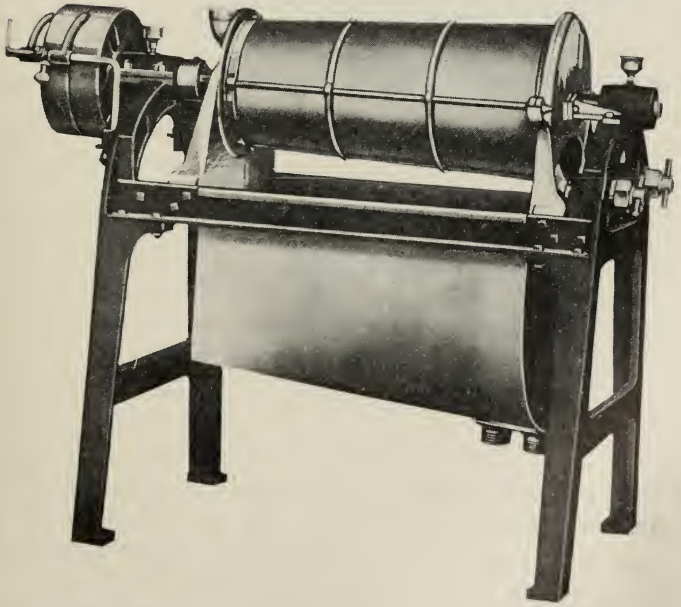

Fig. 2.—Kern finisher used in preparing very fine-grained prune pulp. (Courtesy Anderson-Barngrover Manufacturing Co.)

Prune pulp was found to corrode iron and steel rapidly. The pulper screen should therefore be made of a resistant metal such as copper or monel metal. The holes in the screen should be larger than those used for tomatoes. From the results of the tests it is believed that for quantity production it is best to use a centrifugal brush machine equipped with a screen containing ½-inch x ¼-inch horizontal slits. The best results were obtained by operating the revolving brushes at about 300 r.p.m. The pulp obtained with such a machine was of a desirable consistency and free from pits. For some purposes a fine pulp is desired; this has been prepared by passing the coarse pulp through the fine screen of a tomato catsup finishing machine (fig. 2). In using the wooden paddle "cyclone" pulper it was found that a screen with one hundred 0.07-inch holes per square inch gave the best results. Very coarse sheet-copper screens and rolled-wire screens broke some of the pits, small pieces of which were forced through the screen into the pulp.

A hand operated apple-butter machine (fig. 3) is suitable for use in the home manufacture of prune pulp.

Moisture Content of Pulp.—Prune pulp prepared by different manufacturers and now on the market varies greatly in moisture content. It is desirable that a standard maximum moisture content be adopted.

The moisture content of samples of prune pulps from various sources was determined with the results given in table 1.

TABLE 1

MOISTURE CONTENT OF PRUNE PULP

Sample	Moisture content, per cent	Consistency
No. 10 can	73.42	Thin
No. 10 can	74.2	Thin
No. 10 can	75.4	Thin
No. 2½ can	71.2	Thin
8-ounce can	76.00	Thin
8-ounce can	63.6	Medium
8-ounce can	52.00	Thick

It was found that pulps made in the manner previously described varied from 52 per cent to 76 per cent moisture. A satisfactory pulp contains not more than 74 per cent moisture; an even lower moisture content is recommended (less than 70 per cent).

A very thin pulp is objectionable because its high moisture content amounts practically to adulteration, it attacks the plate of the

tin container very rapidly and it is less suitable than the thicker pulp for most purposes.

Sweetened Pulp.—For the soda fountain trade much of the pulp now on the market is sweetened with cane sugar before canning. This is accomplished by adding cane sugar to the pulp in a steam-jacketed kettle, and stirring while heating. It is usually preserved by the addition of 0.1 per cent of benzoate of soda, so heating is done only as an aid in dissolving the sugar.

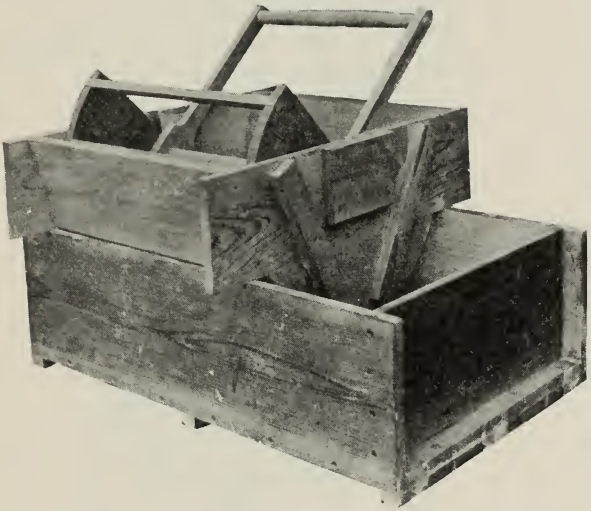

Fig. 3.—Hand operated apple butter machine adapted for home preparation of prune pulp. (Courtesy Anderson-Barngrover Manufacturing Co.)

Utilizing the Juice from Precooking.—Brix hydrometer tests on the waste liquid drained from cooked prunes used in making thick pulp showed that an appreciable amount of soluble prune solids is lost in this discarded water. Typical tests averaged about 14° Brix. The waste liquid however, was in several tests filtered, concentrated by boiling in an open kettle or in a vacuum pan and bottled for use as a beverage.

The juice concentrated in an open kettle was just as good as that concentrated in a vacuum pan. The concentrated juice can be used as a basis for beverages and possibly other uses could be found for it.

Preserving Prune Pulp.—Experiments showed that prune pulp may be canned and sterilized by heat or may be preserved with 0.1 per cent of benzoate of soda or it may be stored at a freezing temperature.

Experience has proved that the pulp should be put into the cans hot. In the preparation of a commercial lot of canned pulp the following procedure was followed. It was poured into a large steam-jacketed kettle (fig. 4) where it was concentrated, by boiling, to less than 75 per cent of moisture, which corresponds to a boiling point of 215° F. The hot pulp was delivered by gravity into a filling machine

Fig. 4.—Kettle adapted for use in making pulp. Note the stirrer. (Courtesy Anderson-Barngrover Manufacturing Co.)

which introduced the pulp into No. 10 plain tin cans (see filling machine figure 5). The cans were not completely filled since other experiments had proved that considerable head space is useful in prolonging the life of the can. This point will be discussed in a later section. The cans were sealed hot. The sealed cans were processed in boiling water for 30 minutes. This time of heating is sufficient if the cans are filled and sealed hot, although heat penetration is slow (fig. 6).

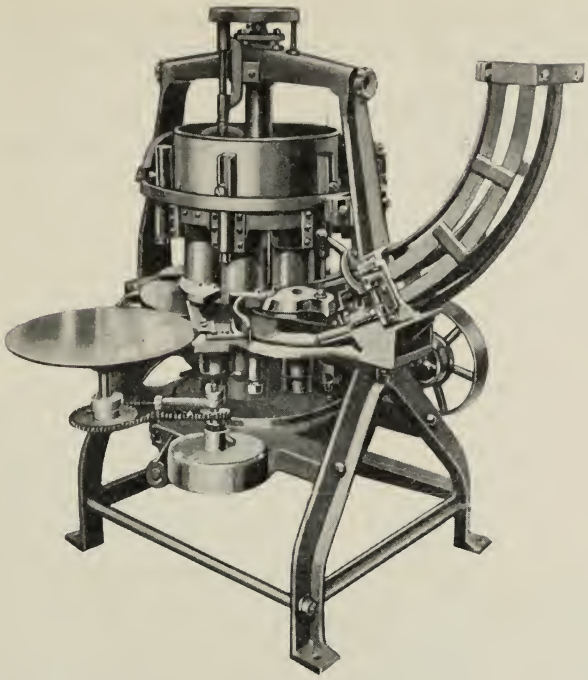

Fig. 5.—Filling machine used to fill cans with prune pulp. (Courtesy Anderson-Barngrover Manufacturing Co.)

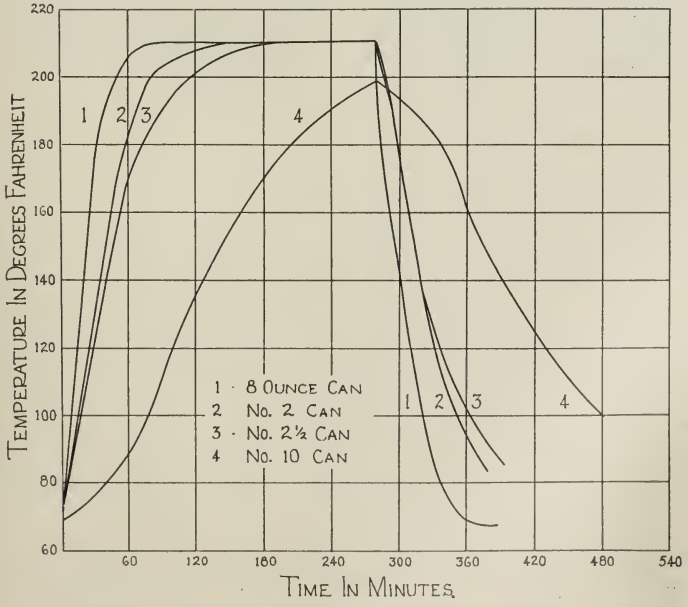

Fig. 6.—Rate of heat penetration in prune pulp.

It was found advisable to cool the hot cans in water a few minutes directly after processing in order to prevent excessive action of the hot fruit on the tin plate.

A number of tests were made to determine the proper weights of pulp for cans of different sizes. Those given in the following table are suggested as tentative "filling-in" weights.

TABLE 2
Filling-in Weights for Prune Pulp

Size of can	Weight of prune pulp
4 ounce	4½ ounces
8 ounce	8½–9 ounces
No. 1 flat	15 ounces
No. 1 tall	17 ounces
No. 2	21 ounces
No. 2½	32 ounces
No 10	7 pounds, 4 ounces
5 gallon	44 pounds, 14 ounces

While cans smaller than No. 10 can be used, the experiments indicate that swelling of the cans from hydrogen gas is much more rapid in the smaller cans, and more likely to occur. However, hydrogen formation in cans of pulp was slower than in cans of ready-to-serve prunes. On account of the more rapid swelling of small cans they should be distributed as soon as possible to the ultimate consumer. At present one packer is canning and distributing nationally, 4-ounce cans of prune pulp with practically no losses from hydrogen swelling.

Number 10 cans of pulp were incubated for more than a year at an average temperature of 85° F with no loss from hydrogen swelling. However, it is advisable to store the cans in a cool place as the rate of corrosion varies with the temperature.

The kind of tin plate or coating was found to have an important influence. Cans made of unenameled tin plate resisted swelling for a much longer time than did those made of tin plate coated with can enamel. Cans made of "charcoal" plate, that is heavily tinned plate, are more expensive than those made of "coke" plate—that is ordinary plate, but their resistance to swelling, particularly in the smaller sizes of cans, compensates for the additional cost.

Pulps of different moisture contents were canned and stored in the same room. The rate of swelling varied with the moisture content, although not in an exact mathematical ratio.

Prune pulp was preserved by adding 0.1 per cent of benzoate of soda and thoroughly mixing until dissolved. A solution of the benzoate is better than the dry powder as it mixes more readily with the

pulp. The benzoated pulp was packed in tin cans and also in wooden containers. When wooden containers were used it was found that they should be as nearly full as possible, in order to prevent dilution of the preservative at the surface of the pulp by the condensation of vaporized moisture. Such dilution permitted mold growth in several experiments in which the pulp was stored in kegs.

Pulp for home use, for bakeries, hotels, restaurants and ice cream factories should be preserved by heat sterilization; but that for soda fountain use is best preserved by benzoate. Fountains require a pulp that will not spoil during standing in the fruit dispenser for several weeks.

Fig. 7.—Containers of frozen prune pulp.

A third method of preservation, that of freezing in fiber-board or tin containers (fig. 7), was also studied. The rate of freezing of pulp was found to be slow (see figure 8) and for this reason the packed material should be placed in the cold room as soon after packing as possible in order to avoid spoiling.

Containers of pulp were placed in a freezing storage room and the rate of cooling was determined by the use of thermocouples and a potentiometer, with the results given in figure 8.

Yield of Pulp.—The yield of pulp from dried prunes is relatively high because of the absorption of water during soaking, and cooking, and usually the weight gained through absorption of water is much greater than that lost by removal of the pits. In a number of factory tests, from 180 pounds of No. 80 prunes, 41.5 pounds of pits, and 357 pounds of pulp were obtained.

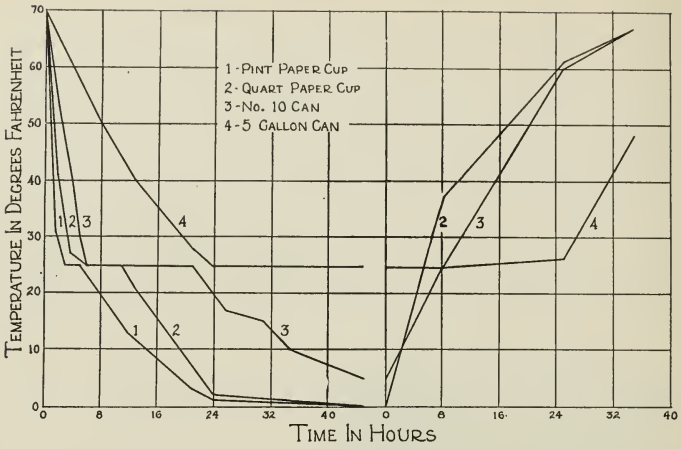

Fig. 8.—Rate of cooling of containers of prune pulp held in freezing storage.

The yield of pits will be less for prunes larger than No. 80 and more for smaller prunes since the ratio of pits to meat varies with the size for any given variety of prunes (see table 3). For the same reason the yield of pulp is less from small than from large prunes.

TABLE 3

VARIATION IN RATIO OF MEAT AND PITS IN VARIOUS SIZES OF PRUNES; GRADED, UNPROCESSED BIN STOCK

Nominal count	Actual count	Per cent pit by weight	Per cent meat by weight
30/40	31	10.9	89.1
40/50	47	11.6	88.4
50/60	56	12	88
60/70	69	13	87
70/80	81	14.6	85.4
70/80	80	15.7	84.3
80/90	85	15	85
120/up	136	22.1	77.9

Some prune packers have believed that the ratio of the pit to meat for similar grades of prunes from different districts varies considerably. Hiltner and Hatherell,[7] however, have shown that this ratio is affected only slightly, and apparently not consistently, by the locality of origin. The data are given in table 4. It is, therefore, reasonable to believe that the same grades of prunes from different districts would give about the same yield or pulp.

[7]From data kindly furnished by R. S. Hiltner and B. E. Hatherall, of the Dried Fruit Association of California, San Jose.

TABLE 4

Ratio of Pits and Meats of Prunes from Various Districts

District	Number of samples	Nominal count	Actual count	Per cent of pits	Per cent of meats
"3 districts" (Santa Clara, Napa and Sonoma districts)	14	40/50	44.3	10.3	89.7
"Outside" districts	2	40/50	48.5	10.7	89.3
"3 districts"	8	50/60	54.7	11.6	88.4
"Outside" districts	12	50/60	55.2	11.1	88.9
"3 districts"	12	60/70	62.4	11.5	88.5
"Outside" districts	6	60/70	61.7	11.2	88.8
"3 districts"	4	70/80	75.2	15	85
Visalia district	1	70/80	74	13.6	86.4
"3 districts"	6	80/90	84.3	15.4	84.6
Visalia	1	80/90	88	15.5	84.5
"Outside" districts	1	100/120	104	14	86
"3 districts"	1	Smallest	222	14.2	85.8

Composition of Prune Pulp.—A number of samples of commercially prepared pulp were analysed in the Fruit Products Laboratory and were found to vary considerably in moisture content. Table 5 gives the average of the analyses of several typical prune pulps. The moisture content of various samples varied from 52 per cent to 76 per cent, consequently the other constituents of the pulp varied accordingly.

TABLE 5

Average Composition of Several Commercial Prune Pulps

	Per cent
Moisture	74–76
Acid (as citric)	0.55–0.60
Ash	0.74–0.79
Pectin	1.84 (average)
Sugar	16.99–17.55
Protein	1.75–1.78
Total solids	24–26

Prune pulp was found to contain a higher percentage of sugar and pectin than fresh peach, apricot or pear pulps, as indicated in table 6. This is an advantage in making candy, jelly, jams, and certain other prune products and also indicates a higher food value.

Approximate Cost of Prune Pulp.—The cost of the pulp varies according to the price of the raw material, its composition, the moisture content of the pulp, size and kind of package, and the efficiency of plant operation. Careful records were kept of yields and costs

during commercial scale experiments conducted in 1928. The costs given in table 7 are based on the data obtained at that time for pulp canned in No. 10 cans. The estimated overhead costs are probably higher than for the average cannery.

TABLE 6

COMPOSITION OF VARIOUS FRUIT PULPS

	Prune	Peach	Apricot	Pear
	per cent	*per cent*	*per cent*	*per cent*
Acid	.6	.52	.81	.21 (malic)
Moisture	74.1	88.9	84.3	84.8
Pectin	1.84	.693	1.36	.706
Total sugar	16.99	8.21	10.65	8.97
Invert sugar	16.99	6.61	10.65	8.07
Sucrose	0	1.60	0	.9

TABLE 7

APPROXIMATE COST OF PRUNE PULP*

	Cost per dozen No. 10 cans	Cost per No. 10 can
80/90 prunes at four cents	$1.74	$0.145
Cans	.85	.071
Case and labels	.45	.037
Labor	.60	.050
Overhead expense (estimated 35 per cent of other costs)	1.27	.106
Total	$4.91	$0.409

* Overhead expense is estimated 25–45 per cent of cost of labor and materials by cannery accountants.

USES FOR PRUNE PULP

Prune pulp is well adapted to use in a number of food products such as ice cream, malted milks, milk shakes, pastry, bread, cookies, cereals, infants food, candy, jam, and fruit butters. It may also be used in various health foods and may be served as a breakfast fruit. Tests made by the Pacific Steamship Co. and others indicate that the pulp is well liked for breakfast by many people who do not eat whole prunes.

Prune Pulp Ice Cream.[8]—As a result of experiments in the Laboratory and cooperative tests with various commercial ice cream factories prune ice cream is now made and sold in the principal cities of the

[8] Turnbow, G. D., and W. V. Cruess. Investigations on the use of fruit in ice cream and ices. California Agr. Exp. Sta. Bul. 434:1–40. 1927.

Pacific Coast. Prune ice cream has proved popular wherever it has been properly introduced to the public. It has proved particularly suitable as a dessert for children and for convalescents.

Prune ice cream was also prepared experimentally with chopped dried pitted prunes, and with sieved canned ready-to-serve prunes but the pulp proved to be the most satisfactory.

An ice cream for the soda fountain trade and for dessert purposes was made by using 15–20 per cent by weight of the pulp with unflavored ice cream mix. This corresponds to about 7–11 pounds to 45 pounds of mix. The yield was about 12 gallons. For a cream rich in fruit a mixture containing about 30 per cent of prune pulp was satisfactory; this corresponds to the addition of pulp in the ratio of 20 pounds to 45 pounds of mix, or 10 pounds to 22½ pounds of mix. The basic mix must contain in this case about 12 per cent of fat in order that the finished cream will contain more than the legal minimum of 8 per cent fat.

The cream with 30 per cent prune is best served fresh, as it tends to become somewhat rough in texture on prolonged storage in the hardening room. With the lower proportion of prune pulp, the ice cream retains its texture very well there.

Ice cream was made also with prunes prepared at an ice cream factory as follows: To 7 pounds of dried prunes was added 4 quarts of water. This was brought to boiling and set aside overnight. It was then boiled gently until soft. The water in which the prunes were cooked was discarded. The fruit was rubbed through a coarse screen, to remove the pits, and used without the addition of sugar.

Small pitted prunes were also used in some tests. They were cooked with about 1½ volumes of water, ground, and used as previously described for pulp and cooked prunes. Unfortunately, these prunes carried a considerable number of pieces of broken pits. For this reason pitted prunes are of doubtful value for use in ice cream.

Harris's Confectionery in Berkeley has found prune one of its most popular ice creams—second only to vanilla. This company has packed prune ice cream for the past two years for sale daily.

Prune Pulp In Drinks.—Prune milk shakes and prune malted milk drinks have proved very popular in central California. The Haas Candy Stores in particular have featured them very successfully. Many other important ice cream and candy stores are serving prune malted milks and prune milk shakes.

It has been found that 1½ ounces (1½ "berry spoons") of the unsweetened pulp and ½ ounce of 60° Balling simple syrup are suit-

able quantities for a prune malted milk or milk shake. At least 2 ounces of the sweetened pulp must be used in order to impart a distinctive prune flavor and color to the drink.

Prune Pulp Pastries.—Prune pulp has been used successfully in Danish pastry and in pies, and tarts. Bakers who have used it in this way report a good demand. They prefer to use the canned pulp to preparing pulp from cooked whole prunes. A large baking company of Oakland is now making Danish pastry with a prune pulp filling as a result of experiments conducted in their plant.

Closed, open, and "criss cross' prune pies have been made with prune pulp by bakers in various cities. Because of the consistency of the pulp the open and criss cross are more satisfactory than the covered pies. The filling has been prepared in a number of ways. See formulas 1 and 2, in the section at the end of this publication.

Prune Pulp Bread.—Numerous baking experiments for the purpose of developing a satisfactory prune bread have been conducted in the laboratory, in the laboratory of the Sperry Flour Company of San Francisco, and in various local bakeries. The two formulas given are based on the results of the experiments and have been thoroughly tested by bakers. See formulas 3 and 4.

Prune bread has been found superior to white bread for toasting and should prove popular for use as a breakfast toast.

Prune Pulp as an Infant's Food.—At a certain stage during the growth of infants it is customary to include prune pulp in the diet. The pulp is usually prepared by the mother or nurse daily by rubbing stewed prunes through a screen. Its preparation is troublesome and time consuming. Prune pulp packed in small cans would be ideally suited for this purpose. Such a product has recently been placed on the market by the Peak-O-Health Products Co. of San Francisco which has found a good and rapidly growing market for the pulp in 4-ounce cans.

Prune Pulp in Candy.—According to a recent industrial census made by the National Confectioners Association about 825,000 tons or 13¾ pounds per capita of commercially prepared candy is consumed in the United States annually, in addition to a large amount of home-made candy. Most of either kind contains little or no fruit. Although most candies are wholesome and nutritious they do not contain the healthful salts and fruit acids found in fruit candies.

For many years a confection has been made by pitting prunes and then filling the pit cavity with fondant or nuts or both. This prune confection has been popular in the home, but little has been produced

commercially because of the cost of preparation. Prunes have seldom been used in standard commercial candies because of the trouble involved in preparing the fruit. Prune pulp is well adapted to use in various candies. Nougat, fudge and jelly prune formulas have been found satisfactory in the laboratory and candy factories. See formulas 5, 6, 7.

Prune jelly candies have more prune flavor and a more tender texture than the other prune candies prepared in our experiments. Formula 7, developed by G. Marsh, of the Laboratory, gives directions for making prune jelly candy.

Prune Pulp in Breakfast Cereals.—Experiments conducted by H. M. Reed in the Fruit Products Laboratory on prune cereals have resulted in overcoming the difficulties at first encountered in incorporating prune pulp in a breakfast cereal. The formula recommended to manufacturers for trial contains approximately 74 per cent of prune pulp on the wet basis (see formula 8).

The prune cereal has the characteristic color and flavor of prunes. The pieces are about $\frac{1}{16}$-inch to $\frac{1}{8}$-inch in diameter resembling grape nuts in appearance. The flavor with milk or cream is pleasing and it is very satisfactory for serving with fruits as a breakfast dish.

Prune flakes have proved to be more difficult to prepare but experiments are still being conducted by Mr. Reed.

Prune Pulp Jam, Jelly, and Butter.—Prune pulp is well suited for preparing jams and butters in the home. The method of preparing the jam or butter is simple. Sugar, equal to the volume of pulp used, is added and the mixture is boiled until the desired consistency is attained. Powdered cloves and cinnamon according to taste may be added near the end of the cooking period. The prune jam can be given a jelly consistency by adding pectin, and a small amount of lemon juice with the sugar and cooking to the jellying point.

Prune Pulp as a Breakfast Fruit.—It has been found that prune pulp served with cream and sugar as a breakfast dish is well received by the average hotel and restaurant patron. The pulp was placed on the S. S. California about a year ago and has become a popular dish with the passengers. The dining room management found that the pulp is preferred to stewed prunes by many passengers.

Prune Pulp as Filling in Newtons.—Large quantities of figs are used by the cracker industry in fig newtons. As a result of a number of laboratory and commercial experiments it has been found that prune newtons can be made easily but the prune filling soon becomes dry and tough and the cake covering rather soggy.

In our tests prune newtons were made in the same manner as fig newtons. Prune pulp was mixed with sugar and glucose or invert sugar syrup and cooked to a heavy consistency and then transferred to the factory's newton machine. When the jam prepared in this way contained a high percentage of pulp, glucose, or invert sugar the newtons became soggy in a shorter period of time than when a high percentage of cane sugar was used.

Prune newtons are very satisfactory if consumed within a short period after baking.

Prune Pulp in Condiments.—Prune catsup and chutney of pleasing flavor were prepared from prune pulp. Formulas 9 and 10 were used in preparing prune catsup and chutney.

Other Uses for Prune Pulp.—Cooking tests made by bakers and housewives have shown that prune pulp can be used in prune whips, puddings, cake, fancy pasteries, mousses, salads, soups, meat sauces, etc. Many such preparations have been served at clubs, restaurants, hotels, and in ship dining rooms, where in most cases they have been received favorably.

Prune Pulp Marketing Experiments.—In cooperation with the California Prune and Apricot Growers Association and various other manufacturers and dealers, prune pulp has been produced in commercial quantities and distributed through various channels to the consuming public. Prune ice cream, prune malted milks, prune milk shakes, pies, prune bread and Danish prune pastry are now being produced and retailed commercially. Prune pulp as previously stated, is now a breakfast dish on the S. S. California. Sieved prunes (prune pulp) in 4-ounce cans for use in the home as a children's food is now being marketed nationally by a cannery located in San Francisco.

These developments have resulted from the experimental factory production and sales conducted under direction of or in cooperation with the Fruit Products Laboratory.

At least five companies are now producing and distributing prune pulp. With sustained sales promotion, consumption could probably be increased greatly as the present development has occurred without extensive or sustained advertising.

DEMAND FOR PITTED PRUNES

Pitted prunes have been produced for a number of years by two large dried fruit packing organizations, but the product has not proved very popular because, so it is stated by those interviewed on

this point, the pitted prunes often contain pieces of broken pits. The present demand for pitted prunes, according to packers, is restricted to a light demand in Germany where they are used in preparing a jam. Recent improvements in pitting machines may improve the product.

PREPARATION OF PRUNE JUICE

Recently many requests for information on sources of supply and methods of manufacturing bottled prune juice have been received. In order to establish a satisfactory method of preparing and preserving the juice a number of experiments were conducted. The following method gave the best results.

The prunes were first soaked in water at 200–212° F for about five hours and then drained. The operation was then repeated a second, third and fourth time with fresh water. The different lots of juice so obtained were combined and filtered through a pulp filter. The juice was then bottled and pasteurized at 175° F for 30 minutes. Juice of about 20° Brix pleased the average consumer best.

The sugar and juice remaining in the leached prunes was found insufficient in amount to warrant pressing. In some experiments prunes were boiled in water and pressed, but the juice was so cloudy and gummy that it could not be filtered. In commercial practice the diffusion battery principle could be utilized. In a typical leaching test in which three leachings were used the following results were obtained.

Weight of prunes used—50 pounds.

Volume of water used in consecutive soakings—12, 7, and 5 gallons.

Time of soaking of each application, 3 hours; total 9 hours.

Concentration of juice from first leaching, 13° Balling.

Concentration of juice from second leaching, 24° Balling.

Concentration of juices from third leaching, 22° Balling.

Average concentration of all leachings, 19.25° Balling.

Total volume of juice obtained after filtration, 14 gallons, or 560 gallons to the ton of prunes.

At a price of 4 cents a pound the cost of prunes per gallon of juice would be 14.3 cents. However, it is desirable to concentrate the juice somewhat before bottling or serving.

If desired, lemon juice may be added before bottling or at the time of serving.

Prune juice is now being served regularly in certain eating establishments in New York.

CANNED READY-TO-SERVE PRUNES IN SYRUP[9]

Canned ready-to-serve prunes have been packed for a number of years but expansion of the pack has been prevented by losses incurred because of corrosion of the containers and consequent spoiling. Spoiling is accompanied by the formation of hydrogen gas and swelling of the cans. Experiments conducted in this laboratory indicate that by observing certain precautions hydrogen swelling can be retarded sufficiently to permit orderly marketing of the product. The more important results of these experiments are as follows:

1. There was little difference in the behavior of sundried and dehydrated prunes in respect to corrosion of the cans.

2. Because of the difference in ratio of surface to volume the relative amount of swelling decreased as the size of container increased. In typical tests the life of No. 10 cans was more than 18 months whereas 4 and 8-ounce cans very often swelled in 3 to 6 months.

3. Plain tin or charcoal plate cans were found superior to cans coated inside with single or double enamel.

4. The prunes should be washed in cold water and then given a short blanch of about 7 minutes in boiling water. When the duration or the temperature of the blanch were increased the rate of swelling increased.

5. In order to have the cans properly filled the weights of blanched prunes given in table 8 were found suitable for prunes of 70/80 size.

TABLE 8

FILLING-IN WEIGHTS OF BLANCHED PRUNES IN CANNING READY-TO-SERVE PRUNES

Size of container	Net contents of prunes
4 ounces	1½–2 ounces
8 ounces	3–4½ ounces
No. 1 tall	7½–8½ ounces
No. 2	8½–10 ounces
No. 2½	13–15 ounces
No. 10	3–3¼ pounds

6. To the cans containing the prunes should be added a syrup,[10] of at least 20° Brix or Balling.

[9] Mrak, E. M., and P. H. Richert. Hydrogen swelling in canned ready-to-serve prunes. Fruit Products Journal 8:5, 6. 1929.

[10] Specifications for California canned fruits, Canners League of California.

7. It was found very important not to fill the cans completely as increasing the head space gives a larger volume for the hydrogen formed in the can and thus delays swelling.

8. The filled cans should be exhausted for 10 minutes at 210° F and sealed while hot.

9. The sealed cans should then be processed in boiling water for one hour in order to soften the prune, although they can be sterilized in a shorter period of time (see figure 9).

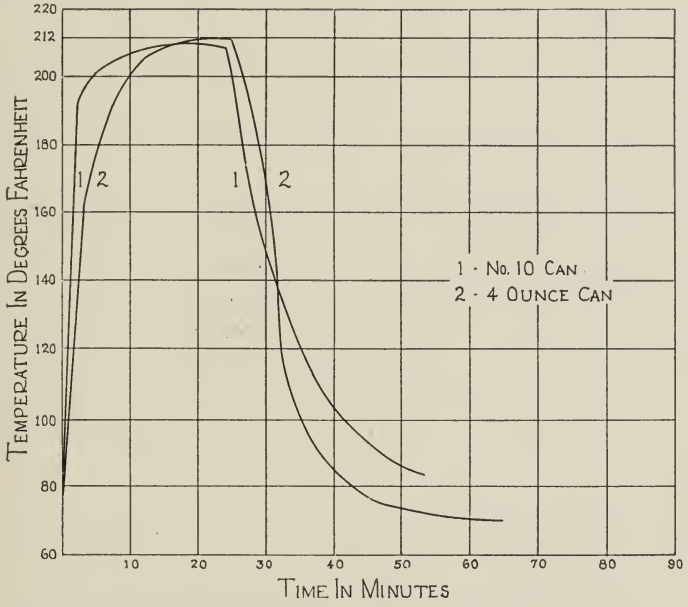

Fig. 9.—Heat penetration in canned ready-to-serve prunes.

10. Cooling for 3–5 minutes in cold water should always follow sterilization. It prevents "stack burn" and retards corrosion, which is more active when the cans are hot.

CANNED FRESH PRUNES

Italian prunes have been successfully canned fresh (without drying) in the Pacific Northwest for a number of years but it has been found in the Laboratory that California French prunes, canned by the same process, are usually poor in appearance and flavor, and rapidly attack the tin plate. However by experiments conducted in the Laboratory and in canneries a fairly satisfactory process was devised. Prunes were canned in two forms, unpeeled and peeled.

Canned Unpeeled Fresh Prunes.—Hand picked firm, well colored, ripe prunes gave much better results than those that had dropped to the ground, because the latter, being bruised, discolored and disintegrated in the can. Thorough washing to remove dust and other foreign material was found necessary. Grading is important since the procedure varies with the size and quality of the fruit.

The cans should be well filled, but not over filled. The "fill in" weight varies somewhat with the size of prune but in our experiments 14 ounces of orchard run French prunes to a No. 2 can gave a satisfactory fill.

Syrups of various sugar concentrations were compared and 40° Balling found best, and an exhaust of 200° F for 10 minutes, sufficient. Twenty minutes heating of the sealed cans in boiling water cooked and sterilized the prunes properly.

Canned Peeled Fresh Prunes.—Canned peeled prunes are superior to the unpeeled in appearance and in suitability for dessert purposes. It was found necessary in peeling to use a lye solution of 15–20 per cent sodium hydroxide (Na OH). The peel was not disintegrated as is the skin of peaches but was merely loosened from the flesh so that rubbing or agitation in water was required to remove it. A peach peeling machine of commercial size was used in the tests. As the peeled prunes darkened rapidly it was found necessary to can them promptly or to store them in a dilute acid solution (½ per cent citric) to prevent discoloration.

The general canning procedure is similar to that described for unpeeled fresh prunes. In several experiments a pit flavor which is often prepared was obtained by cooking the fruit at a temperature not above 180° F for half an hour before sealing and sterilizing.

Peeled prunes are attractive in appearance in glass containers and are suitable also for preparing spiced and pickled prunes.

Canned Fresh Prune Pulp.—Fresh prunes were heated until soft, and were then passed through a pulping machine. A very thin, light colored pulp, weak in flavor, was obtained. This pulp made of green prunes acted severely on the tin plate of cans and caused the formation of hydrogen swells in a very short period of time because of the high moisture content.

Pulp made from fresh prunes was not so suitable for use in ice cream and other products as pulp made from dried prunes.

PRUNES CANNED OR GLASS PACKED WITHOUT SYRUP

Dried prunes have been canned without syrup for a number of years and enjoy a good demand in markets in which carton packed prunes do not keep well as they are safe against insect infestation, bacterial spoilage, and the formation of hydrogen swells, if the moisture content is not too high. Because of these qualities the dry packed prunes are ideal for shipment to tropical climates. They are also popular for use in the home as fruit to be eaten without additional cooking. Naturally they may also be cooked in the same manner as carton packed or bulk prunes, and they cook in a very much shorter period of time.

Canning Without Syrup.—Prunes have been canned successfully in the Laboratory as follows: Graded dried prunes, preferably 50/60 size, were washed and then immersed in boiling water for about 9 minutes. The time of immersion will vary, however, according to the moisture content desired and with the quality and size of fruit used. Too great a moisture content favors corrosion of the can, while too low a moisture content makes the prunes tough. The optimum moisture content appears to be about 30 per cent. Table 9 shows the rate of absorption of water by 70/80 prunes dipped in boiling water in a typical experiment.

TABLE 9

Rate of Absorption of Moisture by 70/80 Prunes in Boiling Water

Time of immersion, minutes	Total moisture after immersion, per cent	Moisture absorbed during immersion, per cent
Prunes before treatment	20	.....
3	24	4
5	26.1	6.1
7	29	9
9	30	10
10	30.5	10.5
15	34.3	14.3

The dipped prunes were then pressed into cans lined with single enamel. The fill-in weights given in table 10 were found satisfactory.

The lids were then crimped to the can by a loose "first roll" in order to hold the prunes in the cans and to prevent moisture absorption during exhausting. The loosely sealed cans were passed through a steam exhaust box at 210° F in 20 minutes. Thorough exhausting was found necessary in order to obtain a high vacuum and to sterilize the fruit (see figure 10).

After exhausting, the cans were sealed while still hot. Additional sterilization is not needed if the above directions are carefully followed. The cans may then be cased and the cases stacked loosely to promote prompt and thorough cooling before shipment.

Tests were made to determine the rate of heat penetration in cans of dry packed prunes with the results given in figures 10 and 11. The time of the sterilization is governed by the size of the can used, and the texture and flavor of finished product desired. Too long a sterilization gives a burned taste and color. A temperature of 175° F is sufficient to sterilize the canned prunes. If they are canned hot and given a long exhaust all parts of the can will usually reach that temperature.

TABLE 10

Filling-in Weights for Prunes Without Syrup

Size of can	Weight of fruit
4 ounce	4 ounces
8 ounce	8 ounces
11 ounce	11 ounces
No. 1 flat	12½ ounces
No. 1 tall	16½ ounces
No. 2 tall	18½ ounces
No. 2½	1¾ pounds
No. 10	5 pounds

Glass Packing Without Syrup.—Dried prunes without syrup may also be packed in glass in a manner similar to that described for canning. However, in glass packing the prunes should be carefully placed by hand, to make an attractive package. See also the next section "French Process Prunes."

French Process Prunes.—This pack differs from that described above in that the prunes are heated long enough to produce a distinct caramel flavor and dark color.

Several ways of producing the caramelization were compared. The prunes were first dipped in boiling water for about 9 minutes. In one method of cooking they were placed in containers in an autoclave and heated in steam at 20 pounds pressure (259° F) for 10 minutes.

In another method they are blanched, packed into containers, and then incubated for 12–15 hours at 180–200° F.

French processed prunes are usually packed in glass containers, which are exhausted, sealed in vacuum and sterilized. If cans are used instead of glass the canning operations are conducted as already described for prunes without syrup.

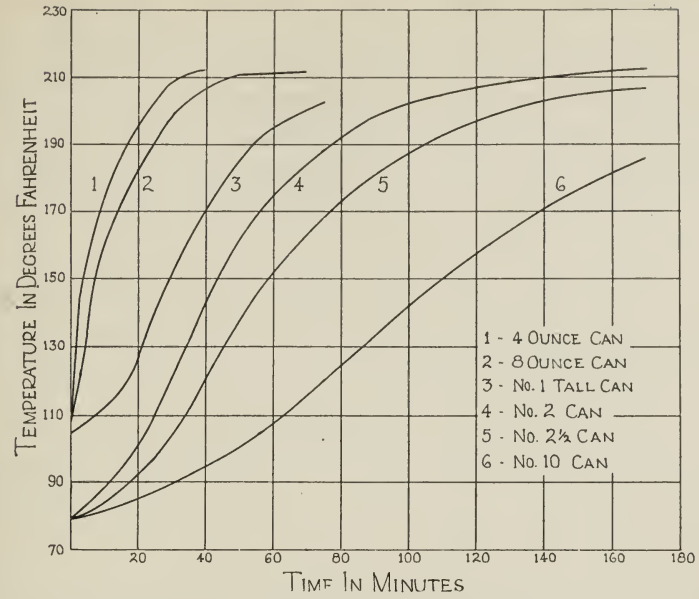

Fig. 10.—Heat penetration in canned prunes without syrup during exhausting in steam at 210° F.

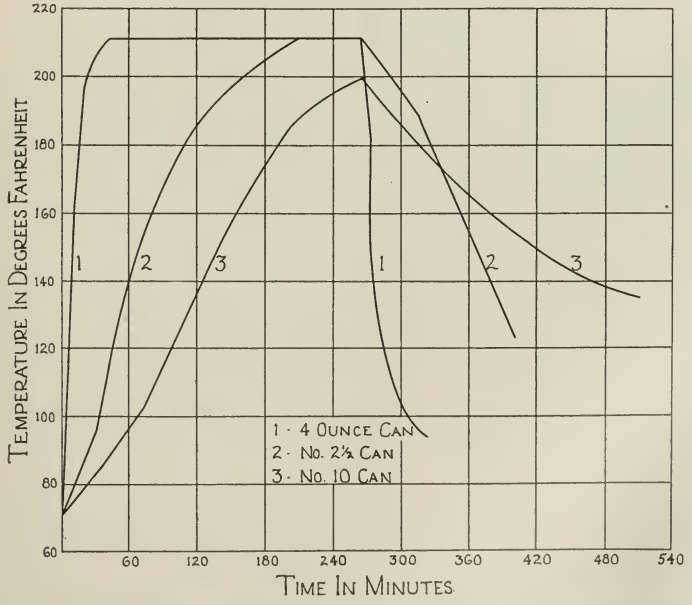

Fig. 11.—Heat penetration in canned prunes without syrup, during processing in boiling water.

Ready-to-Serve Prunes Without Syrup.—As shown elsewhere in this publication canned ready-to-serve prunes in syrup cause swelling of the cans. The larger the head (free) space in the can the less rapid the swelling and the longer the life of the product. The maximum head (free) space is obtained when no syrup is added.

Experiments were made to prepare ready-to-serve table prunes without syrup and the following process found satisfactory: Prunes, of medium sizes, were soaked in water over night and were then cooked until tender. They were then allowed to stand until plump and the water drained off. They were then sorted, canned in 8-ounce cans, the cans exhausted in live steam for 15 minutes, and finally sealed and processed in boiling water for 60 minutes. Larger cans would require a longer processing. The prunes were suitable to serve with milk or cream or eaten as breakfast prunes without addition of sugar or syrup. The liquid drained from them before canning contained a considerable amount of sugar and could be used for soaking and cooking a second lot of prunes. It could then be filtered and bottled as prune juice.

This method of canning seems worthy of trial by canners and of a marketing trial to determine consumer opinion.

PRUNES IN WINE SYRUP

A recent ruling has permitted the packing of fruits in wine syrup containing 50 per cent of sugar and not over 12 per cent of alcohol provided it is done in accordance with the rules of the prohibition department and under their supervision. Permission must be obtained from the Prohibition Enforcement Service to pack fruits in this manner and wine syrup from a licensed manufacturer must be used.

Experimental packs of prunes in wine syrup have shown that the prune and wine flavors blend well and that the product is satisfactory as a breakfast dish. The following procedure proved satisfactory: The prunes were washed, cooked in water until edibly soft, soaked in wine syrup over night and then packed in jars in a fresh lot of wine syrup. The jars were then sealed in vacuum and processed at 185–195° F for 1 hour.

The prunes in wine syrup are a specialty product and would serve a special trade. This product has been served at several banquets and large dinner gatherings where it was well received. At present two canners are experimenting with the product.

USE OF PRUNES FOR FERMENTED PRODUCTS[11]

The utilization of prunes for the manufacture of alcohol, glacial acetic acid, vinegar, and acetone is not at present commercially feasible because the cost of prunes exceeds the market values of these products. This is indicated in table 11.

TABLE 11*

Comparison of the Present Commercial Selling Price of Alcohol, Acetic Acid, and Acetone with the Cost of Prunes used in Making these Products

	Commercial alcohol	Glacial acetic acid	.45 grain vinegar	Distilled vinegar	Acetone
	per gallon	*per pound*	*per gallon*	*per gallon*	*per pound*
Present selling price	48 cents	73 cents	20 cents	20 cents	15 cents
Cost of prunes used in making the products	$1.00	75 cents	40 cents	40 cents	22 cents

* The calculations in this table are based on the minimum amount of prunes used. The cost of prunes for the various products is based on a price of 3 cents a pound for the prunes, a price which is apparently lower than would exist at present in commercial practice.

USES OF PRUNE PITS

The pits obtained in pitting prunes or making pulp are about 79 per cent shells and 21 per cent kernels and can be utilized in the manufacture of charcoal and prune kernel oil. The kernels contain about 41.5 per cent ether extract, 17.5 per cent protein, and 4 per cent moisture and can probably be utilized for oil and cattle food.

SUMMARY

In order to find and develop new methods, and to improve several existing methods of utilizing prunes, experiments have been conducted in the Fruit Products Laboratory and in various factories during the past three years. The more important results have been presented in this publication.

1. A new product, prune pulp or sieved prunes, was developed as a result of the investigations. The manufacture of this product, and its distribution in suitable containers to food manufacturers and

[11] See also: Cruess, W. V. Vinegar from waste fruits. California Agr. Exp. Sta. Bul. 287:1–20. 1921. Cruess, W. V. Commercial fruit and vegetable products. McGraw-Hill Book Co. N. Y. 509 p. 1924.

consumers, we believe to be a promising as well as thoroughly practicable method of disposing of small and off grade but wholesome prunes. This product is beyond the experimental stage and is being produced and distributed by several factories. It is being used in ice cream, pastries, fountain drinks, in candy, as a breakfast dish and as infant's food. A number of other uses for the pulp have been developed and are described in this publication.

2. Pitted prunes can be utilized in many ways but the present pitting methods should be improved in order to completely prevent the occurrence of pieces of broken pits in the product.

3. A demand has been found to exist for bottled prune juice. A simple method of preparing and preserving the juice was devised.

4. There is a large and growing demand for canned ready-to-serve prunes but losses from corrosion of the tin plate by the prunes and syrup, with formation of hydrogen gas has discouraged canners from increasing the quantity canned. Experiments conducted in this laboratory, and reported more fully elsewhere,[12] have shown the cause of corrosion and how it can be controlled. A proper period of exhausting, a large head space in the can and proper adjustment of the syrup density constitute the most important control measures.

5. Improved methods of lye-peeling fresh prunes and of canning unpeeled and peeled fresh prunes were developed.

6. A method of canning ready-to-serve prunes without syrup and a method of preparing so-called "French Process" ready-to-serve prunes in glass were devised.

7. It was found that by proper precooking, prunes can be packed successfully in glass in ready-to-serve form in wine syrup (a syrup made by certain manufacturers under Federal permit and supervision).

8. It is unprofitable to make alcohol, vinegar, acetic acid or acetone from prunes.

9. Prune pits can be utilized for preparation of charcoal and oil.

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APPENDIX

FORMULAS FOR USE OF PRUNE PULP

The following formulas have been developed in the Fruit Products Laboratory and are listed for the convenience of those interested in producing or utilizing some of the products discussed in this bulletin.

1. Prune Pie

1 quart unsweetened prune pulp	1 pound water
½ ounce reground tapioca flour	8 ounces sugar

Bring the water to boiling. Mix the sugar and tapioca flour dry, and then stir into the boiling water. Stir until it thickens, then add 1 quart of prune pulp. Bake in an open pie or cover with strips of crust ("criss-cross pie") in a moderate oven.

2. Prune Pie

½ pound prune pulp	2 eggs
1 cup sugar	½ cup milk

Spices as used in pumpkin pie and lemon juice may be added. Mix the ingredients and place them in a baked crust. Bake slowly in an open or "criss-cross" pie.

3. Prune Bread

6½ pounds prune pulp	6 ounces sugar
5 pounds white flour	5 ounces salt
5 pounds whole wheat flour	3 ounces yeast
2⅓ pounds water	3 ounces lard

Mix and knead the ingredients, make into loaves, allow to rise, and bake in a slow oven.

4. Prune Bread

Whole wheat bread containing 8–10 per cent of prune pulp was found satisfactory.

5. Prune Nougat

7 pounds prune pulp (one No. 10 tin)	7 pounds sugar
	3 pounds glucose
	½ pound coconut butter

In the tests the mixture was cooked until a good "sheeting test" was obtained; this corresponds to a boiling point of 236° F. Then chopped walnuts or almonds were added. The hot material was spread

in thin layers (½ to ¾-inch deep) on paper in wood forms and allowed to cool slowly. After 24 hours the paper was moistened with a wet cloth and then removed. The candy was cut into small squares and rolled in confectioner's sugar, or dipped in chocolate. Some also was packed without coating. An oiled slab was used instead of paper in some tests.

6. Prune Fudge

Lot 1

2 pounds sugar
1 pound glucose
Water to dissolve sugar
3 pounds prune pulp

The sugar, glucose and water were cooked to the "first crack" or 254° F. The prune pulp was then added to the mixture and this was boiled to a soft ball or to 240° F.

Lot 2

3 pounds sugar
1 pound coconut butter
1 pound glucose
30 ounces (5 small cans) condensed milk

The ingredients were mixed and cooked to a hard ball or "first crack," cooled and then creamed by rubbing a stirrer against the side of the cooking vessel. When the mixture had creamed, lot 1 was added to lot 2 sufficiently slowly to maintain the creamy consistency. The candy was then poured on paper or on an oiled slab to harden.

7. Prune Jelly Candy

7 pounds prune pulp
5½ pounds sugar
1¾ pounds glucose
3½ pounds nulomoline (invert syrup)
½ ounce citric acid
1½ ounces added pectin

Add all ingredients except the acid. Boil to 220° F. Have at hand the acid dissolved in a small amount of water and add it at this point and continue cooking to 222° F. Pour and allow to solidify. Before dissolving the pectin use one-half of the sugar given in the formula and mix the pectin and sugar dry. Add water slowly and stir until the pectin is in solution. Add this to the other ingredients.

In factory experiments at the Euclid Candy Co. factory in San Francisco and elsewhere the hot liquid after cooking was poured into starch molds. It hardened and was ready for coating with sugar or chocolate in 3 hours.

8. Prune Cereal

7⅕ pounds whole wheat flour
14⅖ pounds white flour
1 pound baking powder
1 pound salt
2½ pounds fat (a non rancidifying solid fat)
72½ pounds prune pulp

In the experiments the ingredients were mixed into a dough, formed into small loaves in greased pans, and baked 1 hour and 50 minutes at 410° F. Slow baking was found to be essential in order to dry the loaves without burning them. The baked material was sliced, spread on trays and dehydrated at 140° F at an air flow velocity of 500 feet per minute, for 6 hours. The dried material was then crushed coarse, screened to uniform size, and toasted in an oven at 300° F until crisp. It was found that care was necessary in toasting to avoid scorching. The prune cereal has the characteristic color and flavor of prunes.

9. Prune Catsup

1 No. 10 can prune pulp
1⅘ pounds salt
4 pounds chopped button onions
⅗ ounce cinnamon bark
1/10 ounce mace (ground)
⅓ ounce cloves (powdered)
1/10 ounce cayenne pepper (powdered)
1/10 ounce chopped garlic (optional)
⅔ pint distilled vinegar
1/10 ounce paprika

The spices, except the paprika, were cooked slowly with vinegar, sugar and salt about 2 hours. This mixture was strained through a cheese cloth and mixed with the pulp. The final mixture was then heated to boiling, bottled hot and sterilized.

10. Prune Chutney

2 pounds prune pulp
2 pounds dried apricots
1 pound dried peaches
1 pound raisins
½ pound currants
3 pounds sugar
¾ pint vinegar
1 ounce cayenne pepper
½ ounce cinnamon (powdered)
½ ounce cloves (powdered)
½ ounce ginger root

The dried fruits were cut into small pieces and cooked until soft. Then the other ingredients were added and cooked for 20 minutes, stirring the mixture occasionally. The finished chutney was then sealed in jars and stored in a cool place.

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